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UNITED STATES PATENT APPLICATION

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FOR

METHOD AND APPARATUS FOR CALIPER CONTROL OF A FIBROUS WEB

Patent Application

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Title of the Invention

METHOD AND APPARATUS FOR CALIPER CONTROL OF A FIBROUS WEB

Background of the Invention

Large parent rolls of raw material are presently rolled up on a reel after a web manufacturing process. The parent rolls, such as paper, tissue, composite, or like web, are prepared, stored and eventually transported for subsequent finishing and conversion to a final product. In a typical converting process, the parent roll is unwound at one end of a processing line, and is processed through the processing line to thereby convert the raw material, such as to shorter or narrower rolls of product; or to shape products from the raw material, to separate products from the raw material, and/or to combine the raw material with other input elements to thereby create a product or product pre-cursor.

At least one drawback in the present state of the art is that thickness or sheet caliper across parent rolls formed from uncreped through-air dried (UCTAD) sheets may vary undesirably due to the relatively large diameters of parent rolls. Although the caliper difference problem is practically unnoticeable in manufacturing conventional wet pressed tissue wound on conventional tissue machine (TM) reels, caliper difference is a significant problem in high bulk products.

Large diameters typically cause different compressive stresses to the sheets in the parent roll at the top of the roll and approaching the core of the roll,

which can result in significant difference in sheet caliper even after the sheets are converted into a finished product form. In particular, caliper difference in parent rolls for high bulk soft tissue can result in significant differences in the consistency of finished rolls, which not only impacts on the real and perceived qualities of the product but can impair converting line runnability and production efficiency.

Summary of the Invention

The present invention provides a system for controlling the caliper of a fibrous web during winding operations, an apparatus for controlling the caliper of a fibrous web and methods for increasing caliper control of a fibrous web. The component parts of the present invention are simple, reliable, and economical to manufacture, assemble, and use. Other advantages of the invention will be apparent from the following description and the attached drawings or can be learned through practice of the invention.

Notably, the fibrous web discussed herein, such as a tissue web used to manufacture a tissue product, can generally be formed by any of a variety of papermaking processes known in the art. In fact, any process capable of forming a paper web can be utilized in the present invention. For example, a papermaking process of the present invention can utilize adhesive creping, wet-creping, double-creping, embossing, wet-pressing, air-pressing, through-air drying, creped through-air drying, uncreped through-drying, as well as other

steps in forming the paper web. Some examples of such techniques are disclosed in U.S. Patent Nos. 5,048,589 to Cook, et al., 5,399,412 to Sudall, et al., 5,129,988 to Farrington, Jr. and 5,494,554 to Edwards, et al., which are incorporated herein by reference.

According to an aspect of the invention, a method for increasing caliper control of a cellulosic fiber-containing web as the web is wound onto a roll is disclosed. The method includes the step of winding a fibrous web onto a roll to form a wound product. Prior to begin wound, the web is conveyed through a nip. The nip is configured to apply a pressure to the web and to selectively decrease the caliper of the web by increasing the pressure. Specifically, the nip pressure is increased as the diameter of the wound product increases in order to compensate for the caliper reduction that occurs in the web near the center of the wound roll due to compressive forces that are excited on the web as the diameter of the roll increases.

In one aspect of the invention, the pressure may be applied manually via a calender roll in which the calendar roll is incrementally moved toward the web as the parent roll is formed. For instance, a mechanical arm attached to the calendar roll may be controlled by a human operator to move the calendar roll toward the web.

Alternatively, an open loop control of the nip pressure may be employed in which, for example, a mathematical computer algorithm automatically increases the pressure as functions of time, reel length, or roll diameter. More specifically,

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the algorithm can be programmed to automatically adjust the nip pressure over time or with the use of, e.g., a flow meter, a length of passing web, or when a desired diameter is physically reached. The diameter, for instance, may be realized by the open-loop system when a contact sensor is contacted by a surface of the parent roll when the desired diameter is reached.

Another exemplary embodiment may incorporate an on-line caliper sensor to allow a closed-loop feedback control of web caliper. This aspect of the invention may be dependent on the building diameter of the parent roll, which may be determined by the steps of monitoring the caliper of the fibrous web with a sensing device and then adjusting the pressure based on measurements of the caliper from the sensing device. Optionally, the sensing device can be supplemented by a computer to automatically adjust the calender gap or nip pressure in precise micro-adjustments as a function of the building roll diameter D. Alternatively stated, a remote computer can be configured to send commands to adjust the calender roll in small increments toward the web as the diameter of the parent roll increases.

According to another aspect of the invention, nip pressure to a tissue may occur in a converting line as the tissue is being unwound from the parent roll and wound onto a secondary roll or onto a packaging roll. The method may comprise the steps of monitoring the caliper of the tissue with a sensor and controlling the pressure of, for instance, a calendering device, based on measurements of the

caliper from the sensor. In effect, the monitoring and controlling steps form a closed-looped feedback similar to the foregoing closed-looped description.

Other aspects and advantages of the invention will be apparent from the following description and the attached drawings, or can be learned through practice of the invention.

Brief Description of the Drawings

The above and other aspects and advantages of the present invention are apparent from the detailed description below and in combination with the drawings in which:

Fig. 1 is a side view of an embodiment of a system for manufacturing a tissue product in the form of a parent roll in which a caliper of the tissue product is controlled according to the invention;

Fig. 2 is a side view of another embodiment showing caliper control of a finished tissue product in accordance with the invention; and

Fig. 3 is an enlarged perspective view of a section of the invention taken at area III in Fig. 2 showing a caliper sensor in accordance with the invention.

Repeat use of reference characters in the present specification and drawings is intended to represent same or analogous features or elements of the invention.

Detailed Description of the Drawings

Detailed reference will now be made to the drawings in which examples embodying the present invention are shown. The drawings and detailed description provide a full and detailed written description of the invention and the manner and process of making and using it, so as to enable one skilled in the pertinent art to make and use it. The drawings and detailed description also provide the best mode of carrying out the invention. However, the examples set forth herein are provided by way of explanation of the invention and are not meant as limitations of the invention. The present invention thus includes modifications and variations of the following examples as come within the scope of the appended claims and their equivalents.

As broadly embodied in the Figures, a manufacturing system for controlling the caliper of a fibrous web is provided.

Referring to Fig. 1, one embodiment of the present invention is shown. A system 10 includes a dryer 12 such as a Yankee or through-air dryer, a first conveyor 16 and a second conveyor 18, which cooperate to pass a web 14 from the dryer 12 in the direction of a calendering device such as calender roll 20. Calender roll 20 optionally cooperates with a complimentary calender roll or reel 22 to form an open gap or closed nip 24 to apply pressure to a first side and a second side of web 14 as web 14 passes on its way to forming a parent roll 32. The invention contemplates positioning calender roll 20 and reel 22 after dryer 12 and before parent roll 32, or calender roll 20 and reel 22 may be in a converting

line following an unwinding parent roll 32' and before a system such as turret 36 for packaging finished product rolls 40 as seen in Figs. 2 and 3.

As the parent roll 32 is wound and formed in accordance with Fig. 1, a diameter D of the parent roll 32 is monitored and measured by a sensor 26, such as a non-contact laser thickness sensing device or electro-optic sensor. For instance, sensor 26 may be a caliper-sensing device, which measures the caliper of the fibrous web 14 as the web 14 is wound onto the roll 32 to feed back information for regulating the nip pressure generated by calender roll 20 and reel 22.

Alternatively or additionally, sensor 26 may be a contact-type caliper sensor such as a roll-sensing device, which monitors the diameter D of the parent roll as the fibrous web 14 is wound onto the parent roll to feed back information for regulating the nip pressure generated by calender roll 20 and reel 22.

The system 10 may include an adjustment or control device 28, which is operably linked to an adjustment apparatus or arm 30. The control device 28 may remotely or directly control the adjustment arm 30 to alter the nip 24 in micro-increments. Specifically, as the sensor 26 senses the increasing diameter D of parent roll 32, sensor 26 can signal the control device 28, which then directs the adjustment arm 30 to move calender roll 20 towards reel 22 such that the nip pressure in the nip 24 is increased. In other words, a gap (not shown) is decreased and/or nip 24 is further compressed as the diameter D of parent roll

32 increases. The adjustment device 28 can be a programmable controller, such as a microprocessor or a PLC device.

Although Fig. 1 shows sensor 26 monitoring diameter D, alternative embodiments are contemplated by the present invention. For instance, no sensor is required if nip pressure is a function of an operating time of the system 10. Specifically, control device 28 can be programmed to increase nip pressure at predetermined intervals over a preselected system operating time. Alternatively, a trial and error method of caliper control may be utilized in lieu of sensor 26. For instance, a parent roll may be produced, wound and subsequently unwound. The sheet caliper is measured as the parent roll is unwound and caliper variances recorded. Control device 28 or other computer mechanism may then be programmed to apply corresponding nip pressures on subsequent parent roll formations to equalize the caliper variances.

Fig. 1 further indicates that once parent roll 32 is formed with a uniform caliper, the formed parent roll 32' may be moved in a direction away from system 10 such that formed parent roll 32' does not interfere with the formation of a subsequent parent roll.

With reference to Figs. 2 and 3, an aspect of the invention is shown in which the formed parent roll 32' is unwound along a third conveyor 34 in the direction of the carousel or turret 36 to form the finished rolled product 40. With particular reference to Fig. 2, the unwound web 14' is conveyed through calender roll 20 and complimentary reel 22, which again cooperate to form nip 24. Also

similar to the previously described embodiment, sensor 26 in Fig. 3 senses a diameter D' of the building rolled web product 40. The diameter D' is then communicated by wiring 27, for example, to pressure adjustment device 28, which in turn adjusts the adjusting arm 30 to decrease the gap (not shown) or further compress nip 24 and increase pressure on the web 14' to maintain a uniform caliper on the forming tissue product 40.

Optionally, a center-winding device W may be disposed downstream from the calender rollers 20, 22 in the direction of travel of web 14. The center-winding device W may have a cylinder extending therefrom onto which a roll may be placed, and a setting device is provided with the calender rollers 20, 22 to permit control of the nip pressure to increase uniformity of the tissue caliper as the web 14 is wound onto the roll 32 from a core region (not shown) of the roll 32 to an outer region of the roll 32a.

The optional turret assembly 36, shown with particularity in Fig. 3, includes at least one mandrel 38a that is rotatably affixed to the turret 36 for winding the web product 14' into the finished product 40. Six mandrels 38a-f are rotatably affixed to turret 36 as seen in Figs. 2 and 3, but it should be understood that only one mandrel or any number of mandrels greater than one can also be used in the present invention. Additionally, turret 36 as well as other elements of the invention, may be shaped other than as shown such as square, irregular, pentagonal, etc. and be within the scope of the invention.

Figs. 2 and 3 illustrate that once finished product 40 is rolled to its desired diameter D' as sensed by sensor 26, the turret 36 may be rotated by a chain 46 or similar mechanism to move the mandrel 38e and finished product 40 to provide a fresh mandrel 38f with a core 42 on which the web 14' may be wound into another formed product 40. Fig. 3 further illustrates that an adhesive 44 can be applied to core 42 to attach web 14' prior to being wound into formed product 40. Adhesive 44 may be any type of glue or other attachment as known in the art and may be applied to the core 42 in a well-known manner such as by a brush mechanism B.

Figs. 1-3 further illustrate a method of operation of one embodiment of the invention. Specifically, Fig. 1 depicts a method for increasing caliper control of the fibrous web 14 as the web 14 is wound onto roll 32 includes the steps of winding fibrous web 14 to form parent roll 32 which subsequently may form wound product 40.

In this example method, the web 14 may be conveyed through nip 24 prior to winding the web 14 onto the parent roll 32. The nip 24 is configured to apply a pressure to the web 14 to selectively decrease the caliper of the web 14. The calender roll 20 and reel 22 cooperate to apply the pressure as the web 14 is wound onto the parent roll 32.

As Fig. 2 indicates, an alternative method may include applying the pressure to the fibrous web 14' in a converting line as the fibrous web 14' is unwound from parent roll 32' and wound into a secondary roll or formed tissue

product 40. Similar to the foregoing descriptions, the nip pressure may be applied as a function of sensed diameter D' of the finished product 40 or applied by open or closed loop feedback methods or by other manual methods.

It should be appreciated that the present invention has utility for adjusting the caliper of any type of web material and that the type of web material does not in any way limit the invention.

While preferred embodiments of the invention have been shown and described, those skilled in the art will recognize that other changes and modifications may be made to the foregoing embodiments without departing from the scope and spirit of the invention. For example, specific shapes of various elements of the illustrated embodiments may be altered to suit particular applications. It is intended to claim all such changes and modifications as fall within the scope of the appended claims and their equivalents.